APPENDIX 1. Design of Infra-red Aircraft Deicing Facilities

A-1. Overview. The predominant method to deice airplanes relies on the application of aqueous solutions of freezing point depressant (FPD) fluids. In terms of *deicing* airplanes other methods have been employed, such as the mechanical removal of certain types of contamination from airplane surfaces or the placement of airplanes within a heated hangar to melt or loosen contamination. In terms of *anti-icing* airplanes, the only acceptable method continues to rely solely on the application of an appropriate anti-icing FPD. Today, all available FPDs are glycol-based products.

Recent technological developments in the ability of infra-red energy to deliver sufficient, targeted energy to contaminated airplane surfaces have achieved a level, as prescribed in paragraph A-11, that makes this method, *in conjunction with FAA approved airplane ground deicing/anti-icing program*, an alternative deicing method. This alternative method offers an environmental benefit because it is supplemented with little or no FPD during the deicing process. However, since infra-red energy can support only the deicing process, airplanes requiring *anti-icing* protection will still need an appropriate anti-icing FPD.

This appendix provides design standards and recommendations to build infra-red aircraft deicing facility (IDFs). Paragraphs from the main body of this document or within this appendix will be cross-referenced. In the latter case, the referenced paragraph will contain the letter A, e.g. A-4, to designate its location in the appendix instead of the main document. Figure A-1 illustrates an IDF with an entrance taxiway, an infra-red deicing structure, and an anti-icing pad just out of view.

A-2. Design Airplane. In many applications the design airplane used to design an IDF will be a composite of several airplanes. The composite allows the designer to take into account the most demanding airplanes' physical characteristics in terms of sizes and shapes. For example, the composite takes into account maximum tail heights plus their shapes, such as the T- shaped tail section of Dash-8s, vertical heights of wings fitted with winglets, such as the Airbus 320, and fuselage variations within an airplane family, such as the Boeing 737 series.

A-3. Infra-red Deicing Facilities (IDF). IDF have the following basic components:

- **a.** Entrance taxiway,
- **b.** Infra-red deicing structure**,**
- **c.** Nighttime lighting**,**
- **d.** Computerized infra-red energy power unit (EPU) system**,**
- **e.** Computer control room**,**
- **f.** Anti-icing pad**,**
- **g.** Exit taxiway**,**
- **h.** Bypass taxing capability**,** and
- **i.** Runoff mitigation measure.

As optional equipment, IDF may have infra-red ice detection cameras as described in paragraph A-9.

Figure A-1. FAA Boeing 727-100 taxiing into an infra-red deicing structure.

A-4. Siting of Infra-red Deicing Facilities. IDFs shall be sited in accordance with Paragraph 5, *FAA Clearance and Separation Standards Affecting Deicing Facilities.* To initiate control and release of aircraft by air traffic control towers, the perimeter of the facility shall be marked in accordance with paragraph 19 (a) *Pavement Markings for off-gate Deicing Facilities*. With today's improved holdover times of available anti-icers, terminal or cargo ramp areas present promising locations for siting IDFs. For some airports, acceptable sites along a taxiway may better complement the type of operation in use during winter storms. Regardless of the chosen site, the adjoining ground surrounding an IDF needs to be properly graded and prepared to support aircraft rescue and fire fighting (ARFF) vehicles under dry conditions. The requirement provides responding ARFF service access to any section of the IDF during emergencies.

A-5. Entrance Taxiway. IDFs have an entrance taxiway designed, marked, and lighted in accordance with AC 150/5300-13, *Airport Design*, AC 150/5340-1, *Standards for Airport Markings*, and AC 150/5345-46, *Specifications for Runway and Taxiway Light Fixtures*. The section of the entrance taxiway leading into the infra-red deicing structure shall be straight and long enough to permit the longest airplane to align its entire fuselage with the taxiway centerline prior to entering the structure.

A-6. Infra-red Deicing Structure. IDFs have an infra-red deicing structure where airplanes are deiced by infra-red energy.

a. Modular Truss Design. The structure shall be designed in accordance with building code requirements for the jurisdiction having authority. The structure shall be of a modular truss design that offers the owner the flexibility to (1) accommodate changes in airplane physical characteristics and (2) relocate the structure on a seasonal basis. The structural components shall be of an interchangeable type that offers a range of sizes from the same basic structural components in terms of expandable widths, lengths, and heights, each being independent of the other.

b. Modular Truss Construction and Framing Materials. Modular truss components used for framing shall be made of an aluminum alloy or steel. Steel structures to resist corrosion shall be galvanized in accordance with ASTM A 123, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*. Each supporting column shall be anchored to a concrete pier to resist imposed static and dynamic forces, such as, wind loads and snow loads. All components, cross members, fasteners, bolts, etc. shall be positively secured to protect against loosening and the introduction of foreign object damage to airplane turbine engines and propellers.

c. Fabric Cover. IDFs shall be covered by a fabric material (walls and roof) that is flame-resistant in accordance with the large scale test in National Fire Protection Association (NFPA) 701, *Standard Method of Fire Tests for Flame-Resistant Textiles and Films.* Furthermore, the fabric cover should be easy to repair when damaged and of a PVC-coated fabric, as compared to laminated, to improve durability and to protect the base fabric from ultraviolet (UV) light degradation.

d. Lightning Protection. The structure shall be fitted with lightning protection in accordance with NFPA 78, *Lightning Protection Code.*

e. Structure Design Codes. The structure shall be designed in accordance with the building code requirements for the jurisdiction having authority.

f. Fire Safety Codes. The structure shall be designed in accordance with fire code requirements for the jurisdiction having authority.

g. Electric Code. Electric service for the structure shall be designed in accordance with the electric code requirements for the jurisdiction having authority. At a minimum, electrical service shall be installed in accordance with the provisions for aircraft hangars contained in Article 513, *Aircraft Hangars*, of NFPA 70, *National Electrical Code,* and paragraph 2-13 of NFPA 409. Furthermore, all wiring not enclosed in conduits/raceways shall be adequately supported, laced, or banded to reduce wear and damage as the result of jet velocities or prop wash.

A-7. Nighttime Lighting. The IDF shall provide nighttime lighting within the infra-red deicing structure and for the anti-icing pad. The provision for nighttime lighting helps ground personnel to perform deicing and anti-icing processes and to inspect airplanes more effectively. Interior lighting shall be restricted to electricity. Exterior lighting for the anti-icing pad shall be in accordance with Paragraph 10, *Nighttime Lighting*.

A-8. Sizing Infra-red Deicing Structures. The size of infra-red deicing structures shall be determined by clearance requirements that separate the structure framing/infra-red EPUs from the design airplane.

a. Length of Structure. The length of the structure shall equal the length of the design airplane fuselage plus a length that provides for an overhead protective cover (PC). The PC, equally divided front and back of the fuselage length, serves to reduce or eliminate the amount of falling precipitation onto cleaned airplane sections. The PC length shall be in accordance with Table A-1.

Airplane Design Group (ADG)	Protective Cover Length Feet (meters)
ADG II and Smaller	20 feet (6.1 m)
ADG III and Larger	30 feet (9.1 m)

Table A-1. Protective Cover Lengths

b. Height of Structure. In accordance with NFPA 409, the height of the structure shall be such that the closest point of the infra-red EPUs and structural framing clears the most demanding airplane tail section by 10 feet (3.05 m). Precaution in selecting this dimension is necessary since the vertical heights of airplanes vary according to tire pressures and taxiing weights, e.g., operating design empty weight versus maximum design taxiing weight. Therefore, the designer shall take into account the maximum height of all tail sections as provided by the airplane manufacturer(s).

c. Roof Size. The roof of the structure shall be arched to maximize the delivered radiant energy by the EPUs and thereby reduce deicing times. Furthermore, the arched-roof shall be designed with open ends and free of ceiling pockets to eliminate the accumulation of engine exhaust and other vapors. In accordance with NFPA 409, a 10-foot (3.05 m) clearance shall be provided between the arched framing/infra-red EPUs and the most demanding airplane wing configuration, e.g., height of wingtips, winglets. The designer needs to take into account height variations of wingtips, especially airplanes with winglets, when the airplanes are not fully loaded with fuel. To illustrate, Boeing publication D6-58326-1, *747-400 Airplane Characteristics for Airport Planning*, shows winglet on the Boeing 747-400 vary approximately from 22 feet (6.7 m) to almost 31 feet (9.3 m) above the ground. The designer shall use the highest ground clearances provided by airplane manufacturers.

d. Width of Structure. The width of the structure shall provide the clearance between wingtips/winglets and the structural framing/infra-red EPUs in accordance with table A-2.

e. Wall Egress. Each wall shall have one egress between adjacent columns to provide an additional evacuation route for passengers during an emergency. The opening shall be located behind the wing, with a height of 10 feet (3 m) and a width of 12 feet (3.6 m).

Airplane Design Group (ADG)	Clearance Distance Feet (meters)
ADG I and Smaller	10 feet (3.05 m)
ADG II	15 feet (4.57 m)
ADG III and Larger	20 feet (6.10 m)

Table A-2. Wall Clearances

f. Floor Design. The floor shall be designed to carry the maximum anticipated taxiing weight of the design airplane in accordance with paragraph 21 (a), *Pavement Designs*. The floor shall be sloped to allow for drainage (see paragraph A-11(g)). If an infra-red deicing structure is placed over an existing taxiway, the taxiway width shall be expanded up to the supporting structural columns of the structure. In this case, the transverse grade shall be continued for the full-expanded width. The edges of the floor or the expanded taxiway width shall be free of any type of curbing.

g. Drainage System. The floor (including expanded taxiways) shall have a drainage system with a capacity to prevent melt off and other runoff from ponding within the structure. All interior drains should be located near the perimeter of the floor to minimize their exposure to aircraft and vehicular traffic. High strength drainage boxes and covers shall be in accordance with AC 150/5320-5. Additionally, the design of the drainage system shall take into account the ability of the ARFF service to respond to emergencies unimpeded and for passengers to evacuate the structure safely. For example, the drainage system leading away from the structure shall not be of an open ditch design.

h. Floor Markings. The floor shall have two types of markings. First, the floor shall be marked with a taxiway centerline in accordance with AC 150/5340-1. Second, the floor shall be marked with a nose wheel stop mark to indicate the proper placement of airplanes. Since the infra-red EPUs offer the flexibility for zonal application of energies, more than one stop mark may be needed. The facility operator will determine the number and shape and color of stop marks.

A-9. Optional Equipment - Infra-red Ice Detection Cameras. Infra-red deicing structures may have as optional equipment two infra-red ice detection cameras to allow facility operators the ability to scan airplane surfaces prior to and after airplanes are exposed to infra-red energy for the presence of frozen contamination. The cameras shall meet the requirements of SAE Aerospace Standard (AS) 5116, *Performance Standard for Airplane Ground Ice Detection System, Airplane/Ground Based*. Cameras may be either a hand-held system or fixed system with or without separate color monitors that show degrees of frozen contamination. If a fixed system is used, the cameras should be placed in a manner that maximizes the surface viewing areas of airplanes.

A-10. Computer Room. The infra-red deicing structure shall have an enclosed, temperature controlled computer room (CR) to house the computer system that controls the infra-red EPU system, a printer, monitor screens for the infra-red ice detection cameras, telephones, and other equipment necessary to the operation. The CR shall have windows that allow personnel a complete view of the infra-red operation. Location of the CR shall be in accordance with the clearances of table A2. A suitable portable fire extinguisher in accordance with NFPA 10, *Standard for Portable Extinguishers*, shall be provided within the CR.

A-11. Computer-Controlled Infra-red EPU Systems. Infra-red EPU systems need to deliver sufficient radiant energy at appropriate wavelengths that target specific types of contamination without damaging airplanes. Therefore, systems shall deliver radiant energy in accordance with the two-part test criteria from the following subparagraphs. An independent lab shall evaluate the system. FAA reserves the right to retest all candidate infra-red EPU systems at its discretion. Furthermore, systems shall be computer-controlled to ensure greater operational control and improved efficiency to remove contaminates. Such control allows specific infra-red EPUs to vary their energy levels and exposure times independently for zonal applications. Thus, operators can tailor the deicing process to tackle the differences in airplane shapes and sizes and the variations in the types and thickness of contamination adhering to a single airplane.

a. **Contamination-Time Performance Criteria.** Infra-red EPU systems shall remove contamination from test panels within the prescribed times shown in table A-3. The contamination-time criteria requirement shall be conducted in accordance with the test method outlined in subparagraph A-11(b).

b. Test Method for Contamination-Time Criteria. Test panels are to be contaminated with artificially produced ice layers. Once prepared, test panels are inclined and exposed to an overhead infra-red EPU system. The time to remove ice layers completely is recorded and compared to table A-3. For time measurements, ice removal is defined as the complete absence of ice from the upper surface of a test panel excluding water droplets from the drip edge. Three time trials shall be run for each required ice thickness. The longest time interval from each of the three time trials shall be used to determine pass/fail.

Testing Materials:

a. Test panels, six in all, shall be three-foot square flat plates of aluminum alloy AMS 4037 in accordance with SAE AMS 1428, *Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian (Pseudoplastic), SAE Types II, II and IV,* latest edition.

b. Artificial ice shall be produced by freezing American Society for Testing and Materials (ASTM) D 1193, *Reagent Water*, Type IV water.

Test Procedure:

Step 1: **Artificial Ice**. Six test panels will be required. Test panels shall have temporary walls attached to their edges to create a ½-inch (1.25 cm) high dam effect. For example, the dam effect can be obtained by using a paraffin wax, silicon, or a caulking compound to hold water. Pour Type IV water into the six test panels to obtain three test panels with a depth of 1/8 inch ± 1/16 inch (1.25 cm ± 0.15 cm) and three test panels with a depth of 1/4 inch ± 1/16 inch (0.64 cm ± 0.15 cm). To help measure the ice thickness, small rubber washers having the prescribed depths can be used. Test panels shall be cold stored at 25-28 °F (-4.0 to –2.5 °C) for at least 8 hrs to allow the Type IV water to freeze completely. All temporary walls are to be removed before test panels are exposed to radiant energies.

Step 2: Inclined Test Panels. Place test panels onto a supporting structure that is 3 feet ± 1 inch (91.5 cm ± 2.5 cm) above the floor. Test panels shall then be inclined at 10 degrees ± 0.2 from the horizontal. Make sure that the lower edge of the test panel is slightly above the supporting structure, approximately ½ inch (1.25 cm), to allow unfrozen water to flow freely from the inclined panel.

Step 3: Overhead Infra-red EPU System. Center the candidate infra-red EPU system directly overhead of the test panel such that the lowest part of the unit housing is at a distance of 10 feet ± 1 inch (305 cm ± 2.5 cm) above the top of the test panel.

Step 4: Testing Locations. Conduct evaluations in an enclosed area or outdoors having an ambient room/outdoors temperature of 25-28 °F ± 2 ° (-4.0 to –2.5 °C) with little or no breeze, less than 5 mph (8 km/hr.)

Step 5: Time Duration. The time clock starts upon igniting the infra-red EPU system. The clock is stopped once all observable ice contamination is removed from the upper surface of the test panel. That is, the ice has vaporized or melted and dripped off the inclined test panel. Three recorded time trials shall be run for each ice thickness. The longest time duration recorded for each of the two ice thicknesses shall be used to determine acceptance.

Contamination Type and Thickness	Maximum Removal Time Permitted (minutes)
1/8-inch Ice	5
1/4-inch Ice	10

Table A-3. Contamination-Time Criteria for Infra-red Energy Power Units (EPUs)

c. Heated Panel-Time Criterion. Infra-red EPU systems shall not overheat non-contaminated test panels in accordance with subparagraph A11(d).

d. Test Method for Heated Panel-Time Criterion. Clean, non-contaminated panels are inclined and exposed to the same infra-red EPU system to evaluate the rate of heat built up for a specified time within the test panels. The same test panels and infra-red EPU system from the previous test are used.

Test Procedure:

Step 1: Inclined Test Panels. Use three clean, non-contaminated test panels and place them in the same position as described in subparagraph A11(b)(2).

Step 2: Overhead Infra-red EPU System. Place the infra-red EPU system in the fashion as described in subparagraph A-11(b)(3).

Step 3: Thermocouples. Attach two thermocouples down the middle of each test panel. The first thermocouple shall be placed one foot from the top of the test panel. The second thermocouple shall be placed one foot below the first thermocouple. Cover the thermocouples in such a manner to minimize a temperature rise as a result to radiant energy exposure. Thermocouples used shall have an operating temperature reading range from +10 to +250 °F (-12 to +121 °C) with a tolerance of 1 ° F (0.5 °C).

Step 4: Testing Locations. The requirements in subparagraph A11(b)(4) are to be followed.

Step 5: Acclimated Test Panels. Before the system is energized, allow the test panels to become temperature acclimated. That is, the thermocouples should reveal a stabilized panel temperature. Record the panel temperature to be used for pas/fail determination.

Step 6: Time Duration. The time clock starts upon igniting the infra-red EPU system that is set to the same operating level to remove ice in subparagraph A-11(c). Thermocouples shall record the temperature rises continuously for a total exposure time of 10 minutes. Three test panels shall be tested. Acceptable systems are those where the maximum temperature rise as measured in step 5 remained below 150 °F (83.3 °C) for all three tested panels.

A-12. Installation of Infra-red EPU Systems. Installed infra-red EPU systems shall be gas-fueled. Individual infra-red EPUs comprising the system shall be at least 10 feet (3.05 m) away from airplane surfaces for the airplanes expected to use the facility (NFPA 409, paragraph 2-12.5.2). Gas-fueled infra-red EPU systems, which includes the gas supply and storage, shall be treated as a hangar heating system and shall be installed in accordance with NFPA 409, paragraph 2-12, and NFPA 54, *National Fuel Gas Code*. The main gas supply system(s) shall be equipped with manually operated control valves and emergency safety shutoff valve(s). The manually operated valves shall be located at strategic points inside or immediately outside the structure so that the main gas supply can be shut down quickly in the event of an emergency. A large placard shall indicate the location of all control and emergency safety shutoff valve(s).

A-13. Infra-red EPU System Configuration.

a. Radiant Energy Zones. The entire infra-red EPU system shall be placed in an overhead configuration that provides effective radiant energy to the design airplane. Additionally, the configuration shall consist of independently operated energy zones that allow the operator to use all energy zones in the system or pre-selected energy zones. For example, the operator could use only those energy zones that are better suited for small airplane applications.

b. Maintenance. Infra-red EPU systems shall be located in areas that do not subject them to injury by aircraft or ground equipment. Provisions shall be made to assure accessibility to individual infra-red EPUs for scheduled maintenance purposes.

A14. Computer Hardware/Performance.

a. Hardware. Infra-red EPU systems shall employ computer hardware consisting of a processing unit, color monitor, and printer. The computer shall have the operating capability to perform software routines with sufficient speed and memory for data evaluation/records.

b. Software Routines. Software routines may be initiated by keyboard and/or by a touch screen monitor. The software shall have routines that allow the operator to:

(1) pre-warm the structure,

(2) regulate the amount of focused radiant energy through low, medium, and high power settings to meet the types of contamination and various airplane configurations,

(3) regulate the duration of radiant energy application for each power setting,

(4) energize specific infra-red EPUs and at different radiant energies for zonal applications,

(5) shutdown the entire system by a single command button,

(6) print records detailing airplane designation, time of entry to structure, energy settings used and their duration, and time of completion, and

(7) audible warning that indicates a problem has occurred with the infra-red EPU system.

A-15. Anti-icing Pad. IDFs shall have an uncovered anti-icing pad where airplanes are anti-iced with an appropriate FPD. Generally, the anti-icing pad will adjoin the infra-red deicing structure. The anti-icing pad shall be marked with a taxiway centerline and lighted in accordance with AC 150/5340-1 and AC 150/5345-46. The length of the anti-icing pad shall be in accordance with Paragraph 16, *Aircraft Deicing Pads*. The anti-icing pad shall be 10 feet (3.0 m) wider than specified in paragraph 16. The 10-foot (3 m) increase shall be used to provide a 10-foot (3 m) vehicle safety zone for parking and staging mobile deicing trucks.

A-16. Exit Taxiway. IDFs shall have an exit taxiway designed, marked, and lighted in accordance with AC 150/5300-13, AC 150/5340-1, and AC 150/5345-46. The section of the exit taxiway leading out of the infra-red deicing structure must be straight and long enough to permit the longest exiting airplane to completely clear the structure before initialing a turn.

A-17. By-pass Taxiing Capability. IDFs shall provide a taxiway route to by-pass the IDF in accordance with Paragraph 11, *Bypass Taxiing Capability*.

A-18. Runoff Mitigation. IDFs shall have a runoff mitigation structure(s) to collect glycol-based products in accordance with Chapter 5, *Water Quality Mitigation*.

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CHAPTER 5. WATER QUALITY MITIGATION

24. **RUNOFF MITIGATING STRUCTURES**. Since deicing/anti-icing fluids are chemical products with environmental consequences, deicing facilities shall have runoff mitigating structures. The recommended structures are those that comprise a mitigating alternative that collects and retains runoff for proper disposal or recycling. In terms of structural best management practices (BMPs), this approach to "control the source" offers airport managers an effective and economical means to comply with storm water permitting requirements. Change 1 to AC 150/5320-15, *Management of Airport Industrial Waste*, provides additional BMPs to mitigate various types of pollutants from entering storm water runoff conveyances.

a. **Treatment Advantages**. The approach to "control the source" offers two treatment advantages. First, it lessens the difficulty of dealing with the facility's deicer runoff by isolating it from airfield storm sewers or from terminal areas that do not divert seasonal flows of glycols. Second, deicing facilities enhance the feasibility of recycling glycols by collecting higher glycol concentrations, as compared to drainage systems where glycols are further diluted with other runoff and precipitation.

b. **Treatment Parameters**. Of the discharge parameters the alternative needs to mitigate, biochemical oxygen demand (BOD) and toxicity are the primary runoff effects requiring control. The additives in fluids may have an effect on the overall biodegradability. Depending on the type of discharge permit, the alternative would need to monitor specific items, generally based on BOD_5, chemical oxygen demand (COD), total organic carbon (TOC), total suspended solids (TSS), oil/grease, pH, and flow rate limits.

25. **MITIGATION ALTERNATIVES**. The mitigation alternative should allow users of the deicing facility continued use of deicing fluids within the framework of Federal, state, and local storm water runoff regulations (discharge permits). It is strongly recommended that the proposed alternative be reviewed by the Federal, state, or local environmental authority having jurisdiction to verify its effectiveness to place the deicing facility in regulatory compliance. Prior to final selection, all alternatives should be evaluated on a life cycle cost basis to avoid an accepted long term alternative with a short useful life, for an example see paragraph 26, PUBLICLY OWNED TREATMENT WORKS (POTW). Additionally, it should reflect the best alternative afforded by the facility's site and integration with the airport master drainage plan. A few alternatives are:

a. off-airport biological treatment of facility runoff at POTWs by way of a sanitary sewer. See paragraph 26, Publicly Owned Treatment Works, for additional guidance.

b. on-airport detention basin with pump station for discharging metered runoff to receiving waters by an airport storm sewer. See paragraph 27, Detention Basins, for additional guidance.

c. on-airport ~~-~~anaerobic ~~-~~biochemical reactor for pre-treatment ~~-~~of runoff ~~p~~prior to discharge to POTWs ~~-~~or detention basin. ~~.~~ See paragraph 30, Anaerobic Biochemical Systems.

d. on-airport underground storage tanks (UST) or concrete vaults for detention of runoff for hauling tankers to siphon for proper disposal. For airports lacking the physical space for detention ponds, USTs near the facility is an alternative. See paragraph 28, Underground Storage Tanks, for additional guidance.

e. on-airport recycling system. See paragraph 29, Recycling Glycol Fluids, for additional guidance.

f. diversion boxes for diverting seasonal glycol runoff to a specific location, such as a detention basin.

Depending on the site and storm water permitting requirements, one of the above alternatives and/or other technologies working in tandem should provide the airport manager with an effective alternative acceptable to Federal, state, and local environmental authorities.

26. **PUBLICLY OWNED TREATMENT WORKS (POTW)**. Off-airport biological treatment of facility runoff at POTWs is a proven mitigation alternative. This alternative normally requires the airport manager to monitor flow volumes and pretreat glycol contaminated storm water to protect the receiving POTW facility, for example see paragraph 30. Areas of probable pretrea~~t~~tment are high BOD_5, COD, TOC, TSS, pH, and oil/grease. Of these, treatment of glycol BOD loads is of primary concern since some data measure an impact load of approximately 3,000 times that of raw human sewage. To protect POTW, the United States Environmental Protection Agency (USEPA) developed a national pretreatment strategy (1977) under the Clean Water Act. The regulations were published as 40 CFR Part 403. Airports in smaller communities considering this alternative should not only evaluate the POTW's current capacity but whether it can accept both future load demands from the airport and a growing community.

27. **DETENTION BASINS**. For airports with available physical space, an economical alternative to treating "first flush" runoff from deicing facilities is by a single or series of detention basins. The state or local authority having

jurisdiction generally sets construction and design standards. Impermeable liners to protect the groundwater and/or monitoring wells to detect breached liners are likely to be required.

a. **Sizing**. Biodegradability rate, which varies by glycol types, is a primary factor for determining basin capacity. Basin capacity can be reduced by taking into account the slower microbial activity during the winter season and the greater quantity of available oxygen in colder water. Detention of ethylene glycol, which degrades quicker than propylene glycol, permits earlier metered discharges and, thus, reduced basin capacity.

b. **Mechanical Aeration**. The quick consumption of available oxygen levels within basins by ~~glycols~~glycol can lead to anaerobic conditions (lack of oxygen). This condition leads to potential septic conditions (undesirable odors) due to the adverse impacts to bacterial generation necessary for glycol degradation. A recommended corrective action is to install a mechanically aerated system to replenish oxygen levels. This supplemental acceleration of biodegradation and thus, earlier discharging of glycols, further reduces a basin's capacity. The installed system should maintain dissolved oxygen levels at the level that places the alternative in environmental compliance. For some basins, pump stations and force mains may be required if the discharge cannot reach the desired outfall locations.

c. **Wildlife Management**. AC 150/5320-15 provides recommended configurations from a wildlife standpoint.

d. **Other Features**. Additional design features may be necessary if runway deicers containing urea or other effluents are collected within a basin that contains nutrients for plant growth. For instance, the growth of algae blooms under the right conditions may be for some environmental authorities regarded as suspended solids. Their inclusion to the TSS discharge limit may cause this alternative to exceed permitted levels.

28. **UNDERGROUND STORAGE TANKS (UST)**. UST systems that collect ethylene glycol deicing fluids are regulated under the USEPA UST regulations, i.e., 40 CFR, Parts 280 and 281. Though other types of glycols are available which may not be regulated, this alternative has the potential to collect a regulated substance such as aviation fuel. Because of this potential and future use of ethylene glycol based fluids by tenants, it is recommended that this alternative be designed in accordance with applicable USEPA and state UST regulations. For facilities used on a yearly basis, this alternative may collect regulated substances when the deicing pads are used for washing the exterior of aircraft. If a UST is the final collection point, a rigid pad with catch basin may be required for hauling tankers.

29. **RECYCLING GLYCOL FLUIDS**. Depending on the content nature of the runoff and economics, improved technologies are available for recycling spent glycol fluids collected at concentrations of 5 percent and, under certain conditions, even lower percentages. In terms of recycling fluid types that offer longer holdover times as compared to type I fluids, the fluid types are normally more demanding to recycle because of special polymers. This however, is resolved simply by the addition of an extra processing step, thus making recycling an economical consideration. Recycling provides airport management with two valued resources. The first resource is recycled glycol and the second resource is water. Besides recouping some of the chemical cost for glycol and the utility cost for water, other recycling benefits may be reduced sludge disposal costs incurred by other mitigation alternatives and less physical space for equipment.

a. **Recycled Glycol Fluids**. Recycling glycol may offer airport management lower disposal cost of effluent through the resale of recovered product to fluid manufacturers or to other secondary markets. Prior to using recycled glycols as the primary aircraft deicer/anti-icer fluid, recertification in accordance with established industry standards is necessary, for example SAE, ISO. In regard to pavements, recycled glycol fluids may be reused on the airfield pavements if they meet the appropriate glycol-based runway fluid specifications in AC 150/5200-30A, *Airport Winter Safety and Operations*.

b. **Recycled Water.** The limited availability and high costs of water for some airports may make recycling a cost-effective runoff mitigation alternative. Airport management can commit recovered water, if permitted, to irrigate airport landscapes, wash airport/aircraft equipment, or for other non-potable water uses.

30. ~~30.~~ **ANAEROBIC BIOREMEDIATION SYSTEMS~~TREATMENT~~**.

Anaerobic bioremediation systems in conjunction with POTWs or detention basins can be an effective means to dispose of glycol-contaminated stormwater. The bioremediation~~chemical~~ system generally consists of a glycol contaminated stormwater collection and storage system, a bioreactor treatment system, and a gas/heat recovery system. Today many POTWs will only accept limited quantities of glycol-contaminated stormwater. Anaerobic systems, depending on the airport's discharge permit, can reduce BOD_5 concentration levels sufficiently to permit unrestricted disposal to a POTW. For example, one airport-tested system reduced the oxygen demand of incoming glycol-contaminated runoff by over 98%. For those cases where POTWs continue to impose discharge restrictions, the lowered BOD_5 concentration level may be such to allow an increase to the permitted discharge rate. Regarding detention basins, the presence of high glycol concentrations usually makes complete treatment more difficult. Treatment under this condition normally requires considerable more energy for aeration systems and produces large amounts of excess biomass, which in turn, needs be disposed of. Anaerobic systems not only reduce high BOD_5 concentration levels but produce significantly less biomass. When biomass is a problem, anaerobic systems can use activated carbon as the media for attaching the biomass. Furthermore, these systems have demonstrated an additional ability to lower to non-detect levels or remove "additive packages" that are necessary in deicer products from collected runoff. An economical benefit of the anaerobic process is that it converts glycol in runoffs to methane gas that can be used for heating. These systems typically produce more energy than they consume.~~hggghKJK~~